The 3D microanatomy and sperm ultrastructure of the interstitial acochlidian gastropod *Asperspina murmanica* (Kudinskaya & Minichev, 1978)

Timea Neusser[1]*, Alexander Martynov[2], Katharina Jörger[1] & Michael Schrödl[1]

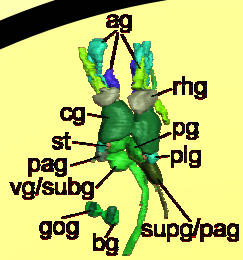
[1]Zoologische Staatssammlung München, Münchhausenstr. 21, 81247 München, Germany
[2]Zoological Museum Moscow University, Bolshaya Nikitskaya 6, 103009 Moscow, Russia
*e-mail: timea-neusser@gmx.de

INTRODUCTION

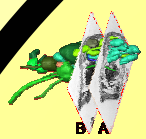
Acochlidia are fascinating opisthobranch gastropods which combine several aberrant morphological and biological features. Most of the 27 species are marine mesopsammic inhabiting interstitial spaces of coastal sand worldwide. The acochlidian phylogeny is still not resolved and cladistic analyses are hardly feasible due to, amongst others, little detailed structural information and incorrect anatomical data from older species descriptions. *Asperspina murmanica* is the single known polar acochlidian species (Kudinskaya & Minichev, 1978) and was thought to be basal due to the retention of a well-developed tube-like mantle cavity (Fahrner & Haszprunar, 2002). This study re-examines in detail the micro-anatomy of specimens which were collected at the type locality in the Barents Sea, Russia, in August 2005. Histological semi-thin serial sections were prepared and a computer-based 3D-reconstruction of all major organ systems was made using AMIRA Software.

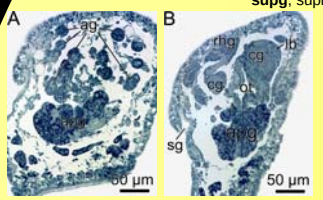
A: Type locality. **B:** Yarnyshnaya Bay at low tide. **C:** Habitat of *A. murmanica*: coarse sand between stones.

Living specimen of *A. murmanica*.



3D-reconstruction of the central nervous system (dorsal view). ag, precerebral accessory ganglion; **bg**, buccal ganglion; **cg**, cerebral ganglion; **gog**, gastro-esophageal ganglion; **pag**, parietal ganglion; **pg**, pedal ganglion; **plg**, pleural ganglion; **rhg**, rhinophoral ganglion; **st**, statocyst; **subg**, subintestinal ganglion; **supg**, supraintestinal ganglion; **vg**, visceral ganglion.

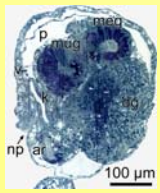




Semithin transverse sections of the central nervous system. A: Precerebral accessory ganglia. **B**: Cerebral and rhinophoral ganglion. **ag**, precerebral accessory ganglion; **apg**, anterior pedal gland;**cg**, cerebral ganglion; **lb**, lateral body; **ot**, oral tube; **rhg**, rhinophoral ganglion; **sg**, sperm groove.

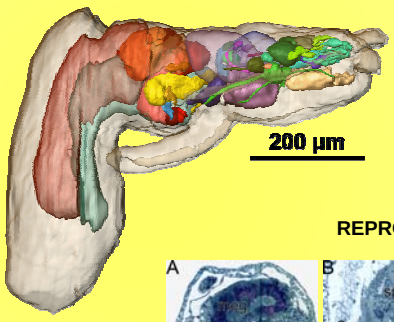
CENTRAL NERVOUS SYSTEM

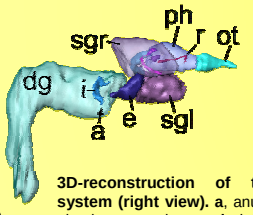
3D-reconstruction of the excretory and circulatory systems (right view). k, kidney; **nd**, nephroduct; **p**, pericardium; **v**, ventricle.



Semithin transverse section of the excretory and circulatory systems. ar, adhesive region; **dg**, digestive gland; **k**, kidney; **meg**, membrane gland; **mug**, mucous gland; **np**, nephropore; **p**, pericardium; **v**, ventricle.

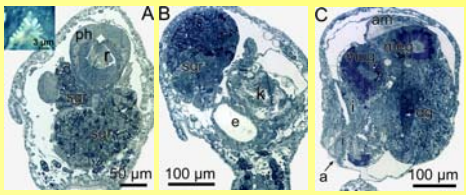
EXCRETORY and CIRCULATORY SYSTEMS



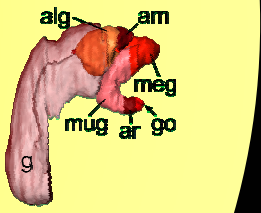


3D-reconstruction of the digestive system (right view). a, anus; **dg**, digestive gland; **e**, esophagus; **i**, intestine; **ot**, oral tube; **ph**, pharynx; **r**, radula; **sgl**, left salivary gland; **sgr**, right salivary gland.

DIGESTIVE SYSTEM

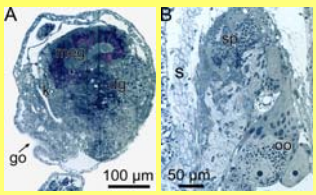


Semithin transverse sections of the digestive system. **A**: Pharynx and salivary glands. Insert: Rhachidian tooth. **B**: Esophagus. **C**: Anus and digestive gland. **a**, anus; **am**, ampulla; **dg,** digestive gland; **e**, esophagus; **i**, intestine; **k**, kidney; **ph**, pharynx; **meg**, membrane gland; **mug**, mucous gland; **r**, radula; **sgl**, left salivary gland; **sgr**, right salivary gland.

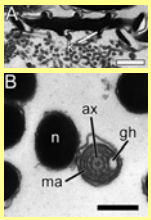


3D-reconstruction of the reproductive system (right view). alg, albumen gland; **am**, ampulla; **ar**, adhesive region; **g**, gonad; **go**, gonopore; **meg**, membrane gland; **mug**, mucous gland.

REPRODUCTIVE SYSTEM



Semithin transverse sections of the reproductive system. A: Gonopore and membrane gland. **B**: Oocytes and spermatocytes in the gonad. **dg**, digestive gland; **go**, gonopore; **k**, kidney; **meg**, membrane gland; **oo**, oocyte; **s**, spicule; **sp**, spermatocyte.



Sperm ultrastructure (TEM). A: Apical part of the nucleus with helical keels (longitudinal section). **B**: Basal region of the nucleus and midpiece with 2x9+2 axoneme and one glycogen helix (cross section). **ax**, axoneme; **gh**, glycogen helix; **k**, keel; **ma**, matrix; **n**, nucleus. Scale in A: 500 nm; scale in B: 400 nm.

CONCLUSION

To our surprise, the microanatomy of *A. murmanica* differs considerably from the original description:

1) Presence of precerebral accessory ganglia and absence of a genital ganglion.
2) Presence of an one-chambered heart.
3) Well-developed reproductive system with nidamental glands.
4) Absence of any mantle cavity: the gonopore, nephropore and anus open separately and directly to the exterior!

The sperm ultrastructure resembles that one of *Microhedyle remanei* (see Neusser et al., 2007) in having an elongate spiral and keeled nucleus and a midpiece with a single glycogen helix. There is no more indication for a basal position of *A. murmanica* within the Acochlidia.

This study was financed by a grant of the German Research Foundation (DFG SCHR 667-4 to MS). 3D-reconstruction was supported by the GeoBioCenter LMU/Germany.

REFERENCES

Fahrner A & Haszprunar G 2002. Microanatomy, ultrastructure, and systematic significance of the excretory system and mantle cavity of an acochlidian gastropod (Opisthobranchia). *J. Moll. Stud.* 68: 87-94.

Kudinskaya EV & Minichev YS 1978. Psammological studies. Morphology and systematic placement of the mollusc *Hedylopsis murmanica* n. sp. (Opisthobranchia, Acochlidiida). *Trudy Peterhof's Biol. Inst. Leningr. Univ.* 26: 69-86.

Neusser TP, Heß M, Haszprunar G & Schrödl M 2007. Sperm ultrastructure of *Microhedyle remanei*, an interstitial acochlidian gastropod with dermal fertilization. *J. Mar. Biol. Ass. UK* 87: pp 1-18.